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New Scales and Scaling Arguments in Boundary Layers. KAPIL CHAUHAN, IIT, HASSAN NAGIB, IIT, USA, PETER MONKEWITZ, EPFL, Switzerland — Flat plate turbulent boundary layers at high Reynolds numbers are studied based on experiments in the National Diagnostic Facility (NDF) and other measurements. The range of Reynolds number based on momentum thickness, Re_θ, for the NDF zero-pressure gradient data is between 12,000 and 62,000. Experimental results for the mean flow are analyzed to reveal appropriate scale relations. It is found that the ratio of mean time scale, x/U_∞, and turbulent time scale, δ_{99}/u_τ, can be used as a significant flow parameter and not just for order of magnitude estimations. Then, the Reynolds number dependence of the wake parameter in the outer region is reevaluated and its strong dependence on the constants of the logarithmic law is assessed. Next, the behavior of the shape factor H for zero pressure gradient boundary layers is discussed in the limit of very large Reynolds numbers, where H approaches unity very slowly. Turning to the mean velocity profiles, the conventional outer scaling of the mean velocity defect is compared with other recently proposed velocity scales and it is concluded that u_τ is the proper velocity scale in the overlap and wake regions. Finally, a new outer length scale Λ, analogous to the outer scale used in pipes and channels, is proposed to clarify issues related to the limit of infinite Reynolds number.

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